

DEPARTMENT OF AGRICULTURE,
CEYLON.

BULLETIN No. 58.

Some Preliminary Notes

ON THE

COCONUT CATERPILLAR IN CEYLON

(*Nephantis serinopa*).

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Peradeniya,
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DEPARTMENT OF AGRICULTURE, CEYLON.

BULLETIN No. 58.

SOME PRELIMINARY NOTES ON THE
COCONUT CATERPILLAR IN CEYLON.

INTRODUCTION.



THE coconut areas situated along the east and west coasts of Ceylon have suffered for many years from the attacks of a caterpillar which eats away the underside of the older and lower palm fronds. The leaflets, if badly infested, gradually curl up along their length and eventually turn grey and die. In a bad attack thousands of palms may be affected, and only the top three or four young fronds remain green and uninfested. This pest has been commonly known as the "Black-headed Coconut Caterpillar," presumably because of the dark head of the young caterpillar. The heads of the later stage caterpillars are usually brown, and, seen from above, the first two segments behind the head are also brown. For the sake of convenience it is proposed to call this pest simply the "Coconut Caterpillar," since this name seems to be in fairly general use at present, and since this insect is the only important caterpillar pest of coconuts in Ceylon.

Previous History in Ceylon.—This caterpillar was known in the Batticaloa District of the Eastern Province for many years previous to 1906, when an outbreak was investigated there by E. E. Green, then Government Entomologist.* The results of these investigations are mentioned in the course of these notes. Before 1906 the outbreaks of this pest had occurred apparently on more or less definite areas at intervals of a few years, and almost invariably during the early months of the year, from February to May. Since that time, however, the attacks on the east coast have been tending to become chronic, until within recent years the caterpillar has been prevalent almost continuously throughout the year in one part of the coconut area or another. This pest is becoming a menace to the coconut industry in the Batticaloa District, and is likely to cause serious losses annually, unless organized measures are

* "Tropical Agriculturist," July, 1906, p. 83.

taken to control it. On the western side of the Island the coconut caterpillar first attracted serious attention in 1907 in the Colombo District, but it was doubtless present before this date and passed unnoticed. Within the last few years outbreaks have occurred in the Negombo and Chilaw Districts, and coconut areas in the Southern Province have been invaded by this pest.

PRESENT STATUS OF THE PEST.

The present situation is that the coconut caterpillar has become well established in the majority of the coastal areas of coconuts on both sides of the Island, while its outbreaks are more frequent and more extensive on the eastern coast than on the western. So far as is known at present, this pest has not invaded the inland areas at higher elevations, but its exact distribution has not been determined.*

In September, 1921, the coconut caterpillar (*Nephantis serinopa*) was declared a pest under the Plant Pests Ordinance, in order that certain measures of control might be enforced where necessary. In view of this fact, it has been thought desirable to give an account of the habits and life-history of this pest, as known at present, and of the measures which have been recommended for its control. The following notes are based mainly on the investigations made by E. E. Green several years ago, and by the present writer at intervals during the past year.

LIFE-HISTORY AND HABITS OF THE DIFFERENT STAGES.

The coconut caterpillar, in common with other caterpillar pests, passes through four stages in its development, namely, egg, caterpillar, pupa (or cocoon), and moth. All coconut growers should endeavour to become familiar with the appearance of all these stages, as far as possible, so that they may be able to detect the presence of the pest on their palms, and be in a position to take prompt measures for its control.

Moths.—The moth, or adult stage, is a small greyish insect with a faint tinge of yellow about the body and the hind pair of wings. The fore wings, or front pair, are greyish and faintly mottled with minute black spots, seen only in a fresh specimen, as shown in figures 1 and 2. Both pairs of wings are slightly fringed and somewhat rounded at the tips. The female moth is about three-quarters of an inch long. The male moth is similar to the female in general appearance, but is smaller. The moths have not been observed to be very active at any

* *Note added.*—The Coconut Caterpillar (*Nephantis serinopa*) has been found recently in the Kurunegala District. (November, 1922.)

Plate II.



Palms from which affected leaves have just been cut.

healthy palms recover rapidly even after an attack of the above description, but their yield is considerably reduced for a year or two after the pest has died away.

Food Plants of the Coconut Caterpillar.—In addition to the coconut palm (*Cocos nucifera*), this caterpillar is able to breed on several other kinds of palms, notably the palmyra (*Borassus flabellifer*), and on ornamental palms, such as *Livistona*, *Archontophoenix*, and others. It has not been observed to attack the "Kitul" (*Caryota urens*), or the Betel-nut (*Areca catechu*).

CONTROL MEASURES.

These should aim at checking the caterpillar pest in the early stages of its attack before it gets a chance to increase. When an outbreak of caterpillar starts on tall palms, it is often no easy matter to detect the injury until large patches of the lower fronds dry up. Even then the drying up of the fronds may be mistaken for the natural withering, to which all older fronds are subject before they finally drop off. Or, again, the "spotting" of such fronds may be attributed to a leaf spot disease which is sometimes prevalent on estates, and which at a distance is not unlike the discolourations which result from the feeding of a few caterpillars in the early stages of an attack.

CUTTING AND BURNING OF INFESTED FRONDS.

In districts where the coconut caterpillar is known to occur, the planter should always be on the lookout for the first signs of any spotting of the lower fronds, and should have a few suspected fronds cut off and examined. If it is found that these fronds show traces of the characteristic webbed galleries of the caterpillar, then the most effective method of checking the pest, and the safest in the end, is to remove and burn without delay all fronds which bear the slightest evidence of caterpillar attack. At this early stage of the outbreak it is only the older leaves which are affected, and their removal will cause no serious harm to the trees, and will certainly be the means of controlling what might develop into a serious and widespread outbreak, which would lower the vitality of thousands of bearing palms and cause a marked reduction in the subsequent yields of nuts. Palmyra palms are also attacked. All such palms growing on coconut estates and along the roadside should be treated as soon as the pest is noticed, or removed altogether.

It is a comparatively simple matter to check a caterpillar outbreak on quite young palms where the damage can be detected easily and no climbing has to be done. Coolies can be sent round to cut off every part of the fronds which shows the

slightest sign of caterpillar attack. These pieces of leaf should be collected into heaps and burnt without delay. The infested area should be inspected periodically every two weeks, in order to destroy any caterpillars which may have hatched since the last cutting. The cutting and burning of infested fronds or portions of fronds will destroy the three immature stages of the pest, namely, the eggs, caterpillars, and cocoons, which are nearly always found on the fronds. This is the most effective method of control which can be recommended for use by all coconut estates and gardens, but it is essential that this measure be carried out as soon as the presence of the pest is detected, and that it should be employed by all owners of coconut trees, whether they be large or small proprietors, or villagers with a few trees in their compounds.

OTHER MEASURES.

Light Traps.—As mentioned above, the immature stages of the pest can be destroyed by cutting and burning all infested leaves, and the emergence of a large number of moths is automatically prevented by this means. The presence, however, of a number of egg-laying moths which have already emerged, and of cocoons which have escaped destruction and which will produce moths a little later, insures the continued breeding of the pest, unless these moths can be destroyed before they have laid their eggs. The use of light traps is suggested for the destruction of moths which are prevalent during the early stages of an outbreak. The use of light traps to catch the egg-laying *Nephantis* moths has been practised on a small scale by a few planters in the Batticaloa District with varying success, but has never become general, even in spite of the fact that they were scheduled under the Plant Pests Ordinance for a short time, as it is considered by some planters that they do not catch *Nephantis* moths in sufficient numbers to compensate for the trouble and expense involved.

These traps are composed of a light placed over a shallow pan containing water and a film of kerosine or other oil. The use of oil on the water is advisable for trapping and killing the moths, many of which would escape if water alone were used. The pan should be at least 24 inches across, and should be raised off the ground from 4 to 5 feet. Either acetylene or oil lamps may be used, and both kinds have given fair results on a small scale under favourable weather conditions and when coconut moths are fairly abundant, but they give practically no result on very wet nights or bright moonlight nights. The light traps, in order to give the best results, should receive daily attention, and should only be used under responsible supervision. It is

Plate III.



A badly affected estate showing the cutting of leaves and portions of leaf stalks left to prevent weevil attack.

suggested that light traps be used in the early stages of a *Nephantis* attack in conjunction with the cutting and burning of infested fronds, and these measures should prevent the enormous increase in the numbers of the pest which might otherwise take place.

These light traps should be used on all favourable nights for a period of at least ten weeks after the presence of the pest is first detected. Ten weeks is about the average time taken by the pest in its development from egg to moth, so that the use of the traps throughout this period should destroy the majority of egg-laying *Nephantis* moths which have emerged just previous to the introduction of the traps, or which continue to emerge throughout the ensuing ten weeks. If it is found that *Nephantis* moths are still being caught at the end of ten weeks, the light traps should be carried on until the planter is satisfied that no more coconut moths are likely to be caught at that time.

How to distinguish Nephantis Moths.—All users of light traps will have noticed that the moths of the coconut caterpillar are by no means the only moths which are caught by the traps, and that not only are a number of other moths trapped, mostly small grass moths, but also many other small insects. This being the case, it is essential that the planter should be able to distinguish the coconut moths from the other small moths, so that he can tell whether his light traps are justifying their use. A reference to the description of the *Nephantis* moths given above will indicate that the female moths are of a grayish colour with black eyes and no distinctive markings on the wings beyond a few minute black dots, which would rarely be evident after the moths have been soaking in water and kerosine for several hours. The wings are rounded at the ends and slightly fringed. The males are similar to the females, but smaller. Bearing these points in mind, it should not be a difficult matter after a little experience to pick out the *Nephantis* moths from the variety of other small moths which may have been trapped at the same time. Nearly all of these have distinctive colour patterns on the wings which are usually somewhat pointed at the tips.

Fires.—The use of small bright fires on infested coconut estates after dark was scheduled in the Plant Pests Ordinance as an alternative to the use of light traps, and this measure was adopted fairly generally throughout the Batticaloa District during the last few months. The burning of fires to attract the *Nephantis* moths was given a fair trial, and it was found by some planters that, although the moths were attracted to some extent by a bright blaze, yet very few of them

were observed to be destroyed, since after approaching the fire they were often carried upwards by the ascending current of hot air and escaped to the trees again. These observations were confirmed later by the present writer. There is, therefore, no special advantage to be gained by the burning of fires to control the pest unless they are composed of cut palm fronds actually infested with the younger stages of the pest. In which case the fronds should be burnt as soon as possible after they are cut in order to prevent the possibility of any moths emerging from cocoons on the fronds.

Recent experiments by coconut planters have indicated that neither light traps nor fires if used only on a small scale have any appreciable effect in checking the caterpillar pest after it has become well established over a large area, but, as mentioned above, light traps can be used with advantage in the early stages of an attack in conjunction with the cutting and burning of infested fronds, or portions of fronds.

Tar and Sulphur.—The burning of a mixture of tar and sulphur to give off dense clouds of smoke in a caterpillar infested area has been practised on some estates, with some success, it is claimed, especially when young and half-grown palms are attacked. There is no definite evidence to show what effect the smoke has on the eggs, caterpillars, and cocoons, but it is supposed to cause the caterpillars to leave the infested palms. It is safer to cut off and burn the infested portions of the trees so as to make certain of destroying the younger stages.

Spraying.—Experiments are to be tried on a small scale to see what effect the application of a stomach poison to infested fronds will have on the caterpillars. This measure would only be practicable in the case of young palms, and the spray mixture would have to be applied to the underside of the fronds, since the caterpillars feed almost entirely on the under-surface, and therefore it is reasonable to assume that they would only be affected by poison applied to the under-surface. No definite opinion can be given at the present time as to the value of spraying to control the coconut caterpillar, but it is hoped that some results will be obtained from the experiments.

NATURAL ENEMIES.

Parasites.—Under normal conditions the coconut caterpillar (*Nephantis serinopa*) appears to be controlled periodically by its natural enemies, the most important of which are small parasitic wasps and flies. In localities where the parasites are effective, the pest is kept down to small numbers, and outbreaks occur only at long intervals. When the parasite control

is only moderately effective, the outbreaks are of more frequent occurrence, at from two to four-year intervals, and usually on small areas. In such cases the same areas are usually attacked each time and the outbreaks are of comparatively short duration and rarely spread to new areas. Such appear to have been the conditions which have prevailed on the western coast in the past, and which are still prevalent. These conditions are probably due partly to parasite control, and partly to climatic conditions, such as the south-west monsoon.

In the North-Western Province the periodical parasitic control of the caterpillar pest seems to be due mainly to a minute species of brown wasp which develops mainly inside the pupa or cocoon of the caterpillar and prevents the moths from emerging. There are also at least two other species of parasites which attack the caterpillar stage.

During the last year the parasitic control of the coconut caterpillar in the Batticaloa District has been investigated by the writer. It has been found that there are no lack of parasites of *Nephantis* in this district, but it appears that in certain localities some of these parasites are themselves attacked by other parasites, known as hyperparasites, so that their numbers are reduced, and their efficiency in controlling the caterpillar is thereby weakened. The caterpillar, given favourable climatic conditions, coupled with this weakening of its enemies is able to go on breeding in gradually increasing numbers, unless the planter steps in and takes a hand in the control.

The small parasite which is prevalent in the North-Western Province has not been found so far in the Batticaloa District, and experiments are being made with the object of trying to get this parasite established in that district of the Eastern Province. This parasite is not known to have any parasitic enemies of its own in the North-Western Province, and it remains to be seen whether it will be attacked by enemies in the Batticaloa District, and how it will adapt itself to the conditions which prevail on the eastern side of the Island, where there are long periods of dry weather.

GENERAL REMARKS.

Supervision.—It should be clearly understood that even under the most favourable conditions these parasites can only be relied upon to maintain a partial control over the coconut caterpillar. Therefore, the planter should be on the lookout for any unusual increase in the numbers of the caterpillar, and should be ready to carry out promptly the measures recommended above, as part of the estate routine work.

Cleanness and Cultivation.—Coconut estates and gardens should be kept as free as possible from other insect pests, such as the Black Beetle (*Oryctes rhinoceros*) and the Red Weevil (*Rhynchophorus ferrugineus*), and from diseases, all of which help to lower the vitality of the trees. Coconut areas should also receive regular cultivation and manuring in order that the vigour of the trees may be maintained. They will then be able to recover from caterpillar attacks more rapidly than trees which are habitually starved and neglected, and should not suffer any serious permanent injury.

Co-operation.—In order to prevent, as far as possible, a recurrence of the serious and widespread outbreaks of this pest which have occurred in some districts within recent years, it is essential that all coconut growers in the caterpillar-infested districts should co-operate to control the pest. Under certain conditions the pest spreads rapidly, not only within an estate or garden, but also to neighbouring estates or gardens in localities where the cultivation of coconuts is continuous over large areas. It should, therefore, be the aim of every grower of this crop in the infested districts to see to it that his own palms are kept free of the caterpillar pest, not only for his own benefit, but for the good of the coconut industry in general.

J. C. HUTSON,
Peradeniya, June 7, 1922. Entomologist.

time, but remain for long periods resting on the pinnæ or leaflets of lower fronds or at the base of the fronds among the fibrous sheathing. Even when disturbed by shaking or beating the fronds, they only flutter away for a short distance and soon settle down again on other fronds. They are not at all conspicuous during the day, even when numerous, since they flatten themselves out on the fronds with their wings folded tightly over the body, and at a distance they may easily be mistaken for a greyish leaf spot. The characteristic resting position is shown in figure 2, except that the left wing may sometimes overlap the right wing, giving them an even more compact appearance. During wet weather they may retire to more sheltered places and may sometimes be found under estate sheds. They are probably more active at night, when mating and egg-laying usually take place. They are attracted to lights, except on bright moonlight nights.

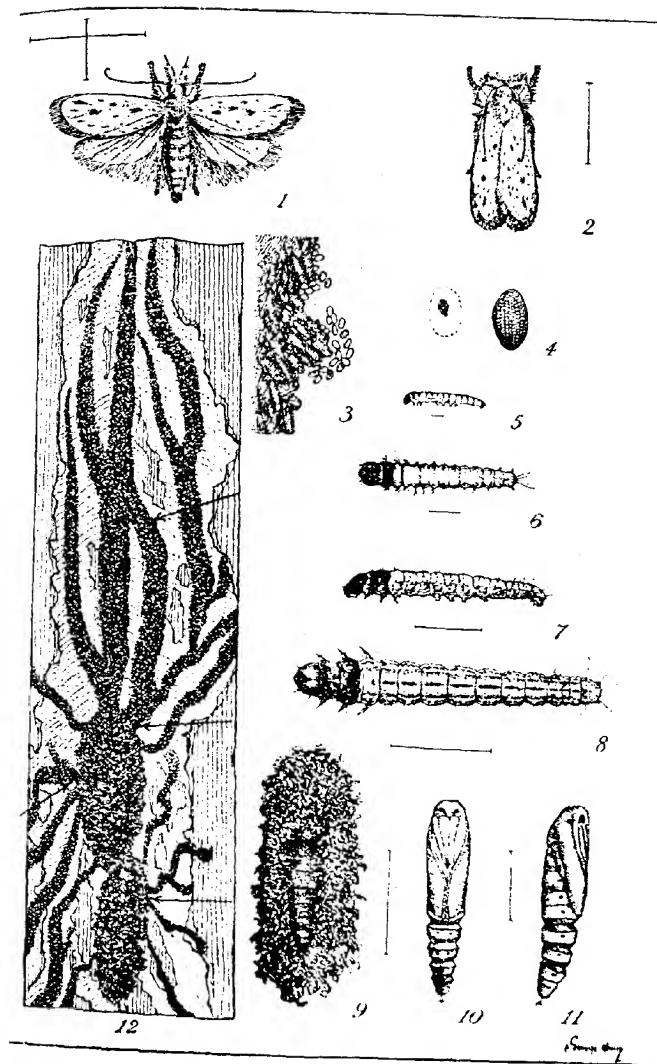
Eggs.—The female moths, as indicated by recent breeding experiments, may mate and begin oviposition within a few days after their emergence from the cocoons. It is not known at present what is the normal number of eggs which a single female may lay, but recent laboratory experiments have shown that one moth may lay over 350 eggs in several batches. Green found that normal batches of eggs consisted of from 12 to 20 eggs, and that the eggs develop in relays inside the body of the moth and are laid at intervals as soon as they attain the right stage of development. He also observed that the eggs while still in the body of the female are of a greenish tint, but after deposition they are pinkish.* The present writer has found that the newly laid eggs are creamy-white, and turn pinkish within two or three days later. Under laboratory conditions the egg-laying period lasts only about ten days, even when the moths are supplied with food. The eggs are very small, and when examined under a lens they are seen to have a ribbed sculpturing, as shown in figure 4.

Position of Eggs.—Green discovered one of the places in which the eggs are laid on palms which have been attacked previously by the caterpillar. He says: "They are deposited amongst the frass and debris of the larval galleries, and are more or less masked by a covering of down from the body of the parent moth." The writer has found that the eggs may be laid in a similar manner on the cocoons, which are covered with the same kind of debris as are the larval galleries. They may be laid actually on the leaf surface under the edge of larval galleries or cocoons, as shown in figure 3. So far as

* "Tropical Agriculturist," July, 1906, p. 83.

the writer has been able to determine from examination of numerous batches of eggs laid in the above positions, the covering of the eggs with hairs or "down from the body of the parent moth" does not appear to be the usual practice. The important point is, however, that in cases where larval galleries are present the eggs are deposited amongst the debris of such galleries, that is to say, they are laid somewhere on the fronds. The position of the eggs, as pointed out by Green, has an important bearing on the control measures, as will be seen later. Green also raised the point that there must be other localities for the eggs, apart from the larval galleries, since, on the first invasion, there would be no larval galleries in which to oviposit. He suggested the possibility that the fibrous matter at the base of the young fronds might form a nidus for the eggs. In this connection the writer has examined a number of young coconut palms in areas which were being invaded by the pest. In the case of palms which had no larval galleries, it was difficult to find any eggs, but a few small batches were found on the under surface of the pinnæ or leaflets, either in a small mass on the blade of the leaflet or in a row along the groove of the midrib. Nephantis eggs were occasionally found among the webbing of spiders' empty egg nests left on the underside of the leaflets. So far the writer has found no indication that under field conditions the eggs are laid among the fibrous matter at the base of the fronds. Further observations may lead to the discovery of eggs being laid elsewhere than on the fronds. It has been observed, however, in cases where moths are confined in breeding cages with uninfested seedling palms, that the eggs may be laid either amongst the fibrous matter at the base of the fronds, or actually on the basal portion of a frond covered by the fibrous sheath, or occasionally the leaf surface.

Larvæ or Caterpillars.—These hatch from the eggs in about ten days, and at first are very small and slender. In the young caterpillar the head is almost black, but it becomes lighter in colour after each moult until in the fullgrown caterpillar it is brown. The young caterpillar is almost cylindrical, with a slight tapering towards the hinder end, but in the older caterpillars this tapering becomes more marked. At first the body is of a pinkish colour, due to series of transverse pink stripes on most of the body segments or divisions, but later on the body is of a pale straw colour with tinges of green and pinkish to reddish-brown lines running the length of the body. In the young caterpillar there is a small dark plate just behind the head, while in the older larvæ this plate is pale brown and the segment just behind it is reddish-brown. Figures 5-8 show four of the five stages of the caterpillar.



NEPHANTIS SERINOPA.

Fig. 1.—Moth, flying position. Fig. 2.—Moth, resting position. Fig. 3.—Eggs laid on leaf under edge of gallery, enlarged three times. Fig. 4.—On the left an egg mass natural size, on the right a single egg to show markings. Figs. 5, 6, 7, 8.—Stages of the caterpillar, enlarged. Fig. 9.—Cocoon turned over

The caterpillars settle down on the undersurface of the pinnae or leaflets soon after emerging from the egg. At first they gather along the groove of the "ekel" or midrib of the leaflet and cover themselves with a few threads. After feeding has begun, they gradually cover these threads with small pieces of leaf tissue and pellets of waste matter to form protective galleries, one or more larvae feeding under a gallery. These galleries are gradually extended to take in fresh portions of the undersurface of the leaflets, and are widened with the growth of the caterpillars. These latter are very lively when disturbed, and move rapidly backwards or forwards with equal facility. Feeding also may take place outside the galleries, but the caterpillars feed almost entirely on the underside of the leaflets, leaving only a thin membrane, the upper epidermis. The coconut caterpillars do not eat holes in the leaves, this type of damage being done by other caterpillars, such as bagworms. Figure 12 indicates the damage done by *Nephantis* caterpillars.*

Cocoons.—The caterpillars are full grown in from six to eight weeks, and spin their silken cocoons usually on the underside of the leaflets and cover them thickly with debris. The caterpillars, after constructing their cocoons, gradually shrink to almost two-thirds of their former size and change into brown pupæ inside the cocoons. The moths emerge from these pupæ in about two weeks. Two cocoons are shown in the lower half of figure 12, while figure 9 illustrates a cocoon turned over to show the pupa inside. Figures 10 and 11 show the front and side views respectively of a pupa removed from its cocoon.

The complete life cycle of the coconut caterpillar (*Nephantis serinopa*) from egg to moth occupies from about ten to twelve weeks. As stated above, the moths soon mate and the females begin laying their eggs within a few days after emerging from their cocoons.

HOW THE PEST SPREADS AND THE NATURE OF THE DAMAGE.

In districts where the coconut caterpillar has been established for many years, and where its natural enemies, such as parasites, diseases, &c., are fairly efficient, it usually happens that outbreaks of the pest occur only at fairly long intervals. During these intervals there are usually a few caterpillars left to carry on either on coconut or palmyra until the next outbreak, since the pest is never quite exterminated by its natural enemies. The damage done by these few caterpillars is very slight and may be confined to a slight spotting of a few fronds in a small area. Such damage usually passes unnoticed, or may not be considered worthy of special attention. Then it may happen

* Notes on these other caterpillars will be published shortly.

that the parasites, now few in number through lack of food, may be further reduced in numbers by their own enemies (see "Natural Enemies"), and there may be a long spell of dry weather unfavourable to the fungous diseases which attack the pest. The result is that nearly all the individuals of the small brood of caterpillars which is carrying on may develop into moths. Some of these moths may lay their eggs amongst the debris of the old larval galleries, while others may fly or get carried by the wind on to palms previously uninfested. The pest is able to develop unchecked in both the old and new areas of infestation, but at first the damage is comparatively slight. Given a continuance of favourable natural conditions and in the absence of any artificial control, such as cutting and burning of fronds or the use of light traps, the succeeding broods of caterpillars increase enormously in numbers, and the damage becomes more evident from day to day. Not only does the severity of the damage become intensified on the individual trees within the area originally attacked, but the infestation spreads rapidly to surrounding trees. Within a few months after the start of the outbreak it will be noticed that the majority of the lower fronds on the first attacked palms have turned greyish-brown in patches, owing to the fact that many of their pinnae or leaflets have been eaten almost bare on the underside. Badly attacked leaflets curl up along their whole length to form tubes within which the caterpillars continue to feed until every green part of the leaflet is skeletonized. If the pest is still allowed to continue breeding unchecked by artificial control, and provided that the natural enemies are still ineffective, the result is that the majority of the fronds on almost every palm over a large area become completely grey and shrivelled, only the younger fronds remaining green and uninjured. The nuts may be partially covered with the feeding galleries of the caterpillars and the young nuts fall prematurely. This nut fall seems to be due to partly to the feeding of caterpillars in and around the calyx, and partly to the weakening of the palms as a result of the loss of most of their leaves.*.

Such is the condition to which some coconut estates are actually reduced by a serious and prolonged attack of caterpillar. Coconut palms sometimes die after repeated attacks of this pest, and in some cases their death may possibly be due to these attacks alone. Usually, however, it will be found that those palms which succumb have been weakened previously by coconut beetles, by disease, or by years of starvation and neglect. It has been noticed on many occasions that normally

* For other causes of nut fall see Bulletin No. 53, "Nut Fall of Coconuts."

